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Passive Factors for the Effective Implementation of the 5S Method in a Manufacturing Company: A Network Thinking Methodology Approach

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Abstract:

Purpose: *The purpose of this article is to present the results of analyses and studies, the result of which is the identification of key factors influencing the effective application of the 5S method in the production area in a manufacturing company. Passive factors, distinguished according to network thinking methodology, were subjected to a detailed analysis. The study attempted to show that these passive factors, which turned out to be the ease of finding tools and the allocation of places for objects, although they have a small impact on others, are themselves subject to strong influences.*
Design/Methodology/Approach: *The article uses triangulation methods. First, the network thinking methodology was used, which allows the problem to be looked at from different perspectives and allows the analysis of factors that occur in the network and the determination of the types and strength of interactions of parts that make up the whole. The research was supplemented by surveys conducted using the CAWI method among production employees of a selected furniture manufacturing company. The sample selection was random.*
Findings: *The results show how the assessment of the ease of finding tools changed – in the opinion of employees – before and after the introduction of the 5S method in the manufacturing enterprise studied.*
Practical implications: *Work tools are the basic equipment of every workstation. Without them, no company can function normally, perform basic tasks and therefore cannot earn money. Downtime can cause significant delays and material losses. Based on the research conducted, guidelines have been provided to solve the problem of proper placement and finding tools at the workstation.*
Originality/Value: *The results presented are a supplement to extensive research conducted worldwide on the effective implementation of the 5S method in the area of production in the enterprise. The study aimed to fill the research gap in this area.*

Keywords: *5S, network thinking methodology, tools at the workstation.*

JEL codes: *L23, D85, M11.*

Paper type: *Research article.*

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1. Introduction

Companies looking for ways to improve the productivity and efficiency of their operations are increasingly looking for organizational changes. They are trying to use the opportunities inherent in improving the processes implemented in the company or improving the systems. To change or improve a process or system, it must first be thoroughly analyzed.

Analysis of activities in the process, the flow of goods and information, identification of waste at the workplace or loss of time are difficult to determine due to the large amount of unnecessary materials and tools at and around the workplace, improper organization of the workplace, lack of information or documentation, and general mess. In such a situation, until the general conditions at the workplace improve, it is impossible to talk about achieving measurable progress and improving the efficiency of the implemented processes.

To improve processes in the entire enterprise, one should start by analyzing the processes and activities taking place at each individual workstation. To improve processes and increase the efficiency of activities at the workstation, several methods belonging to the so-called modern management concepts can be used.

These include, the 5S method, work standardization, KAIZEN, Just in Time, the SMED (Single-Minute Exchange of Die) method, TPM (Total Productive Maintenance), kanban system and many others. The 5S method is worth noting, the effective implementation of which in a company can lead to a clean, orderly and efficiently functioning workstation.

2. Literature Review

The use of new tools and techniques of industrial engineering to increase productivity, quality, and sustainability has been a trend in the manufacturing industry worldwide in recent years. The 5S method is a tool that supports the analysis of processes that occur in the workplace (Bharambe *et al.,* 2020). Its result is an effective organization of the workplace, simplification of the workplace (Liker, 2004), improvement of efficiency and productivity and reduction of losses and downtime (Gupta, 2022), elimination of losses related to shortages and failures (Serin *et al.,* 2020), improvement of work quality and safety (Ho and Cicmil, 1996).

As shown by Gupta's research (2022), the 5S method is mainly used to improve workplaces in production and logistics processes, but the use of 5S is also observed in service sectors such as hospitals, banks, and universities. However, according to Czajkowska (2017), this method is also used in virtual space today.

The 5S technique was developed by Takashi Osada in 1970 and later by Toyota engineers Sakichi Toyoda and Kiichiro started to implement this technique

commercially (Osada, 1991). The name of the method described comes from the first letters of five Japanese words denoting the stages of implementing the 5S method (Peterson and Smith, 1998), Seiri (sort), Seiton (order), Seiso (shine), Seiketsu (standardize), and Shitsuke (continue).

The 5S method is a continuous process of improving the work environment. It is also treated as a tool that helps to reveal problems, and if effectively implemented, it can become an element of the visual control process of lean production (Liker, 2004). According to Chruściel (2023), the 5S method is a low-cost and efficient tool for lean production based on people. It requires the involvement of operators at their own workstations and helps to instill a culture of quality, productivity, and improvement.

According to Palange and Dhatrak (2021), the purpose of an effectively implemented 5S system is to reduce the company's losses, which usually arise as a result of the generally understood waste (Jap. muda). The goal of activities in each process in the company should be added value, i.e. what the customer is willing to pay for, otherwise the company will be dealing with "muda", i.e., loss and increased costs (Mehta and Dave, 2020).

Table 1. *Characteristics and objectives of the five consecutive according to Mehta and Dave, 2020; Bharambe et al., 2020; Joshi, 2015, Sukdeo, 2017).*

Stage	Characteristics	Objectives
Seiri	Selection of items at the workstation, removal of unnecessary items that hinder work.	Better use of workspace in workstations, clean and efficient workstations.
Seiton	Giving proper arrangement to the items available at the workstation.	Facilitating access to tools at the workplace, increasing safety.
Seiso	Removal of all contamination from the workplace.	Maintaining a clean and safe workplace, maintaining and improving the efficiency of machines.
Seiketsu	Maintaining neat working conditions.	Improving the working environment, eliminating the causes of accidents.
Shitsuke	Compliance with all work rules.	Reducing human errors, improving interpersonal relationships.

Source: *Own study.*

The use of the 5S method is based on eliminating unnecessary items and placing them in the right place and maintaining the workplace in impeccable order (Chaurey *et al.*, 2023). In this article, the network thinking methodology was used to identify the key factors that influence the effective use of the 5S method in the production area of a manufacturing company.

The network thinking methodology has its systemic origins and allows for the analysis of the studied phenomena in a holistic way. As noted by Riesener *et al.* (2020), this methodology aims to overcome the dynamic complexity of actions and

ensure completeness, and thus the identified actions are combined into a network of dependencies. The network thinking methodology (Probst and Gomez, 1991) is based on the paradigm of a holistic, systemic approach to the problem. It requires coherence of views, the network of mutual interactions must be thoroughly thought out, and its functioning must be within a specific time frame.

As stated by Butlewski *et al.* (2020), using this methodology allows the discovery of various limitations and barriers that occur in the decision-making process. The foundations of network thinking are based on the concepts and findings of systems theory. According to Borowiec (2019), according to this methodology, the mistakes often made in solving problems are simple cause-and-effect logic and analyzing problems in isolation.

The authors of the network thinking methodology, developed in the late 1980s, are three Swiss scientists. Peter Gomez, Hans Urlich and Gilbert JB Probst (Probst and Gomez, 1989). According to Kubiak (2020), this methodology is an interesting proposal for a broad perspective on problems that occur in an enterprise.

It is a proposal that allows for a better understanding of the mechanisms that occur in an organization and for them to be solved more easily. It is based on the assumptions of general systems theory (Bertalanffy, 1968) and allows for a holistic view of a problem with an extensive structure (Ragin-Skorecka *et al.*, 2019).

The network thinking methodology consists of six interconnected phases. These include (Probst and Gomez, 1991; Ulrich and Probst, 1990; Gomez and Probst, 1995), setting goals and modeling the problem situation, analyzing interactions, capturing and interpreting the possibilities of changing the situation, explaining the possibilities of managing change, planning strategies and actions, implementing the solution to the problem.

3. Research Methodology

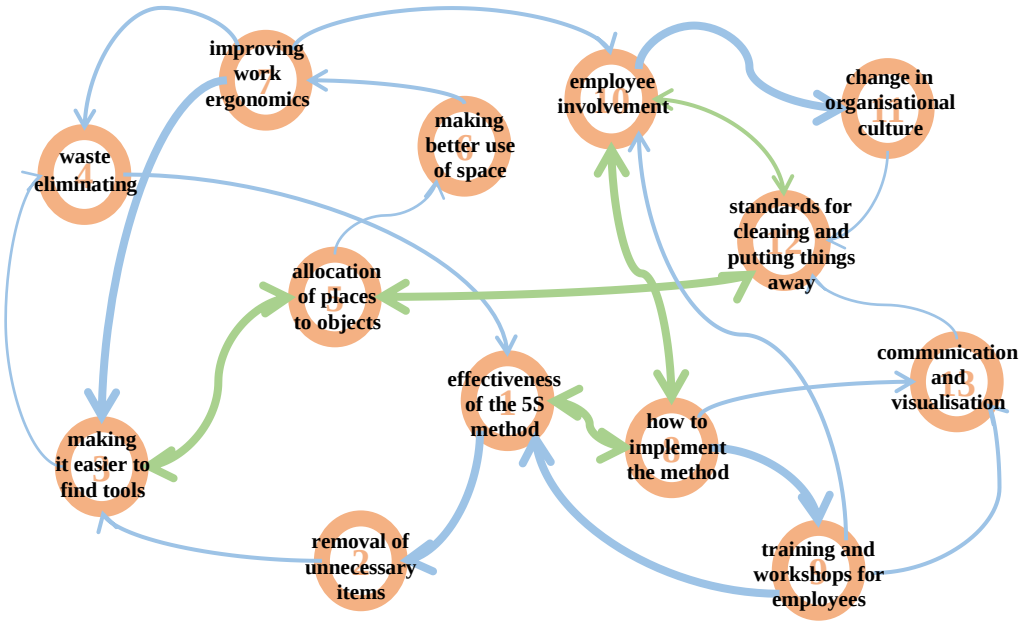
The article uses triangulation of methods (Bans-Akutey and Tiimub, 2021). First, the network thinking methodology was used, which allowed us to look at the problem from different points of view. The objective of the investigation was to identify key factors influencing the effective use of the 5S method in the production area of a manufacturing company. The article presents only elements of the analysis performed according to the network thinking methodology. The individual stages of the operation are presented in Grzelczak (2024).

At the beginning, the factors that influence the problem under study were identified. The factors were linked into a network of interactions (Figure 1) and the types and strength of the interactions of these factors were determined. Then, the intensity of interactions between the factors in the network was assessed. Based on the above

assessment and using the influence matrix, an intensity map was drawn (Figure 2) and the factors were classified into active, passive, critical, lazy.

According to Probst and Gomez (1991), if active and critical factors predominate, it means that the situation can be influenced through these elements. On the contrary, when passive and lazy factors predominate, the possibilities of interference are much smaller. In this article, only passive factors will be the subject of research.

Figure 1. *Network of dependencies for effective implementation of the 5S method in a manufacturing company*



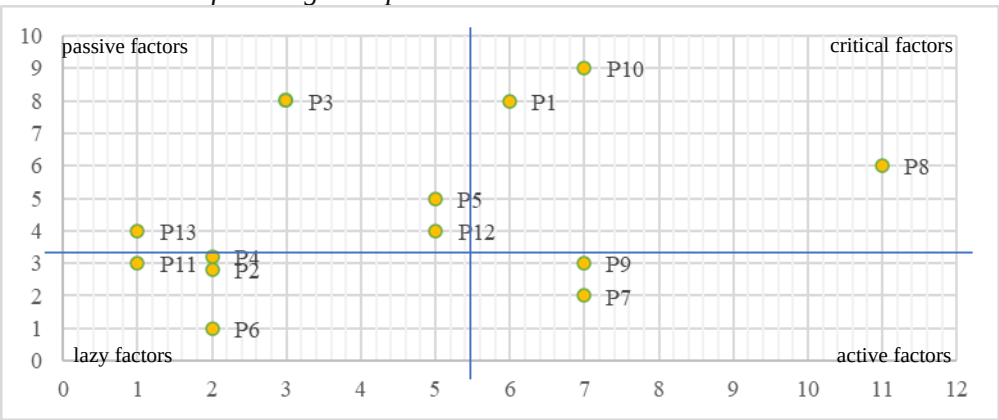
Source: *Own study.*

On the intensity map (Figure 2), dots and numbers mark the location of each factor defined in the network of connections. The critical factors (strongly influencing other elements, but at the same time being strongly influenced themselves) turned out to be the following factors: the effectiveness of the 5S method (1), the method of implementing the 5S method (8) and employee participation (10).

The active factors (which strongly influence other elements but are not influenced themselves) are: improving work ergonomics (7) and training and workshops for employees (9).

The passive factors (having a small impact on others, but being strongly influenced themselves) turned out to be: the ease of finding tools (3) and the allocation of places for objects (5), while the remaining factors are lazy (having a weak impact on other elements, but themselves being influenced only weakly).

Figure 2. *Map of intensity and types of factors for effective implementation of the 5S method in a manufacturing enterprise*



Source: *Own study.*

After conducting analyses using the network thinking methodology, surveys were conducted using the CAWI (Computer Aided Wire Interaction) method. Assisted Web Interview) among production workers (113 people) in a selected furniture manufacturing company in March 2024 in terms of assessing individual groups of factors.

The rest of the article will describe the research results regarding one group of factors, namely passive factors, i.e., those that have little impact on others but are themselves strongly influenced. Two of these factors were included, and it is worth noting that both are interrelated. These factors are: ease of finding tools and allocation of places for objects, including tools.

4. Research Results and Discussion

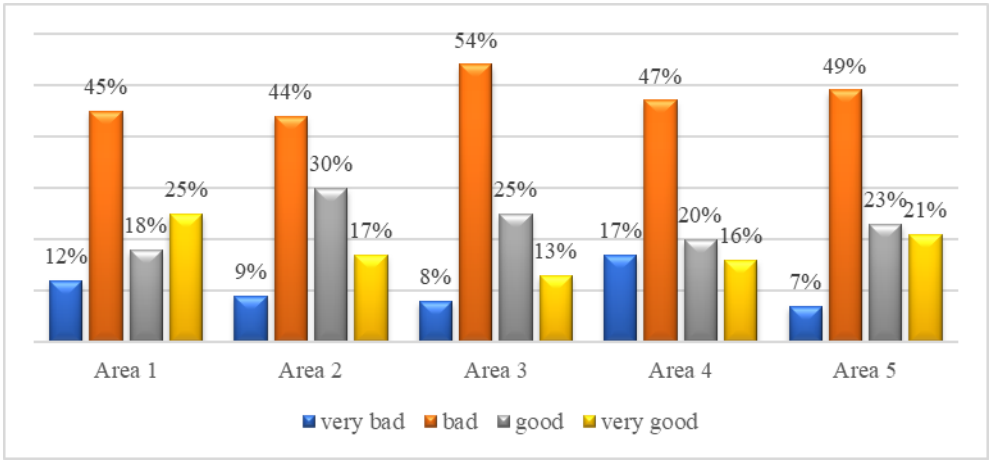
During the survey, employees were asked how they evaluated the ease of finding tools in the workplace before the 5S method was implemented in the company (Figure 3) and after the method was implemented (Figure 4).

When asked about the ease of finding tools at the workstation before the introduction of the 5S method in the surveyed enterprise, almost half of the respondents (from 44% in area 2 to 54% in area 3, and an average of 47.8%) indicated the answer "bad", and another more than 10% (from 7% in area 5 to 17% in area 4, an average of 10.6%) assessed it even "very bad".

The sum of negative indications (answers "bad" and "very bad") ranged from 53% in area 2 to even 64% in area 4 (an average of 58.0%). The number of positive assessments was definitely smaller: the answer "good" was indicated by almost 23% (from 18% in area 1 to 30% in area 2, an average of 22.75%), and "very good" by another almost 19% (from 13% in area 3 to 25% in area 1, an average of 18.4%).

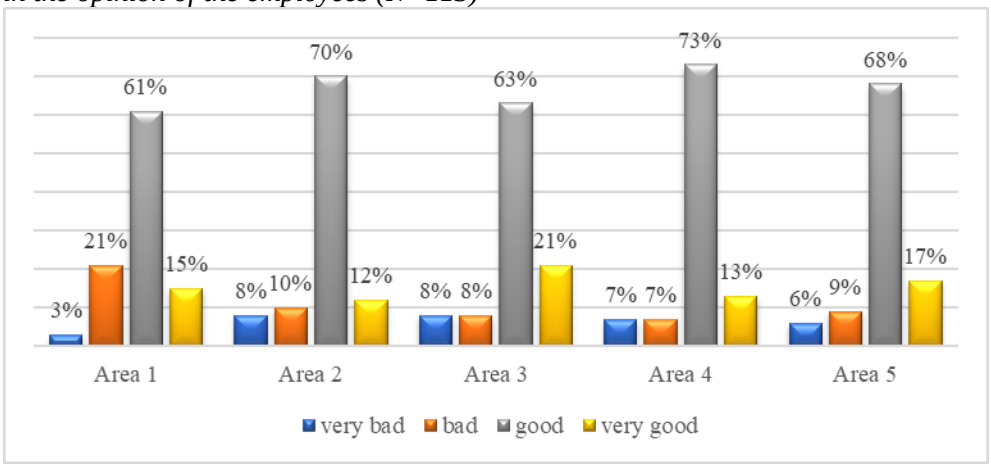
The sum of positive indications (answers "good" and "very good") ranged from only 36% in area 4 to 47% in area 2 (average 42.0 %). The research conducted in five production areas of the analyzed enterprise shows a very high rate of employees who notice a problem in finding tools at the workstation.

Figure 3. *Ease of finding tools on the workplace before implementing the 5S method in the opinion of the employees (N=113)*



Source: *Own study.*

Figure 4. *Ease of finding tools on the workplace after implementing the 5S method in the opinion of the employees (N=113)*



Source: *Own study.*

The situation changes dramatically after the 5S method is applied to the workstations. When asked about the ease of finding tools at the workstation after the 5S method was introduced in the surveyed enterprise, two-thirds of respondents (from 61% in area 1 to 73% in area 4, and an average of 67.0%) indicated the answer

"good", and another more than 15% (from 12% in area 2 to 21% in area 3, an average of 15.6%) assessed it even "very good". The sum of positive indications (answers "good" and "very good") ranged from 76% in area 1 to even 86% in area 4 (an average of 82.6%).

The number of negative assessments is definitely smaller: the “bad” answer was indicated by 11% (from 7% in area 4 to 21% in area 1, an average of 11.0%), and “very bad” by another just over 6% (from just 3% in area 1 to 8% in areas 2 and 3, an average of 6.4%). The sum of negative indications (answers “bad” and “very bad”) ranged from just 14% in area 4 to 24% in area 1 (an average of 17.4%).

To sum up the research conducted in the five production areas of the analyzed enterprise, one can notice not only a very high rate of employees positively assessing the improvement in the situation related to finding tools at the workstation, but also a high increase and improvement in absolute values - by almost one quarter: from 19% in area 1 to 29% in area 5 (24% on average).

The work tools are the basic equipment of every work station. Without them, no company can function normally, perform basic tasks, and therefore cannot earn money. Downtime can cause entire production lines to stop, investments to be suspended, and can cause significant delays and material losses.

Expenditures on tools in companies, especially manufacturing companies, are enormous. Optimizing tool management, i.e. the circulation, location, and use of tools by individual employees can significantly reduce costs and thus increase profits. Based on the research conducted, the following tips (Table 2) are suggested to solve the problem of proper arrangement and the search for tools at the work station.

Table 2. *Description of problems and indication of the solution to the problem*

Problem	Problem description and solution
Employees looking for tools	Tools in the production area are often scattered across different production departments or workstations, as well as tool rentals or cabinets. However, it is the speed of finding and delivering the right tool to the workstation that determines the quantity and quality of work performed. In extreme cases, problems with tool location become a factor that determines the fluidity of production and, consequently, meeting or exceeding the deadlines for tasks and production orders. Solution: Permanently assigning locations to individual tools (so-called shadow boards) eliminates the problems associated with identifying, securing, and finding them.
Employees keeping tools	A common phenomenon in the production area, which is difficult to combat, is the accumulation in their cabinets by employees of not only the tools they currently need for their work, but also those that "might come in handy" in the unspecified future. The lack of control over this phenomenon significantly reduces tool turnover, which translates into

	maintaining higher tool stocks and, consequently, additional purchases that could have been avoided. Solution: Introducing ongoing control of the tool status of each employee, resulting in an immediate increase in equipment rotation.
Employees waiting for tools	The maintenance of tool records (often without IT support) and the way tools are delivered to the workstation are other reasons why employees waste time. Instead of working, employees wait in line for the necessary tools or wait for them to be delivered to their workstation. Solution: Computer-aided tool management allows for faster and more precise tool management in the enterprise (locating and delivering tools to the workstation) than traditional methods.

Source: *Own study.*

5. Conclusions

Nowadays, companies looking for a way to improve the productivity and efficiency of their operations are increasingly reaching for organizational changes, using the possibilities inherent in improving the implemented processes.

One of the methods that allows for the analysis and improvement of processes occurring in the workplace is the 5S method, which results in effective organization of the workplace, simplification of procedures in the workplace, elimination of losses related to shortages and failures, or improvement of the quality and safety of work.

The purpose of this article is to present the results of analyzes and studies, the result of which is the identification of key factors influencing the effective application of the 5S method in the area of production in a manufacturing company. Passive factors (they have a small impact on others, but are strongly influenced themselves) were subjected to detailed analysis, distinguished on the basis of the analysis of factors based on the network thinking methodology, which turned out to be: facilitating the finding of tools and assigning places to objects (including tools).

In recent years, we have observed the evolution from 5S to 7S (Mahlaha, Sukdeo, and Mofokeng, 2020) where the next two aspects were added: Safety and Spirit / Support. The 5S audit sheet in relation to tools at the workplace in the scope of 1S (Sort) includes the question:

Are there unnecessary machining fixtures, tools, dies, documents, etc. at the workstation, and in the scope of 2S (Set in order) it asks the question: are the tools and machining fixtures arranged in a way that allows them to be easily picked up and put away? It is important not to forget about the activities in this area in the scope of the next stages, i.e., 4S (Standardize) and 5S (Sustain), as well as 6S (Safety) and 7S (Spirit).

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